Appendix 3: Ridership Forecasting Methodology

INTRODUCTION

This appendix describes the methodologies used to forecast visitor and resident demand for Bangor – Bar Harbor transit services. Because, visitation levels vary significantly by season, forecasts are presented on an average day, monthly, and annual basis. All forecasts are for the year 2020.

Visitor forecasts were developed for two types of demand:

1. "Mode-Shift," or the number of current visitors who would shift from their existing modes of travel to the new Bangor – Bar Harbor services.
2. "Induced Demand," or the number of new trips that would be induced to come to the Bar Harbor area as a result of the existing of the new transit service. There would be two types of induced demand: (1) additional trips made by current visitors,[1] and (2) new trips made by those who would not otherwise visit Maine.

Both types of visitor demand were estimated using stated and revealed preference methodologies, and were based on the results of two surveys conducted of visitors and potential visitors to Mount Desert Island. The larger of these survey efforts was an intercept survey of people stopping at major tourist and recreation sites on Bar Harbor and at the tourist information center on Thompson Island. This survey aimed to gauge the share of existing travelers who would use the proposed new service. The second survey was a mail out survey to people who had recently requested tourism literature from the Maine Office of Tourism. This survey focused on the potential of the proposed services to *induce* trips to Bar Harbor beyond those that already occurred.

Forecasts of resident travel were estimated using quick-response travel estimation techniques described in the National Cooperative Highway Research Program's (NCHRP) reports 187 and 365.[2] The overall method is a simplified version of traditional four-step transportation modeling, which includes trip generation, trip distribution, mode-split, and traffic assignment, and uses transferable model parameters from other small urban areas in cases where area specific data is not available.

VISITOR FORECASTS

Forecasts of the number of current visitors that would use Bangor – Bar Harbor services were developed using stated and revealed preference methodologies that were based primarily on the results of two surveys conducted in the summer of 2001. This main survey effort (the "on-site" survey) was an intercept survey of visitors to Mount Desert Island. For five days in mid-July (including a Saturday and Sunday), project staff distributed questionnaires to visitors at major tourist sites on or at the entrance to Bar Harbor. A total of 1,581 usable surveys were collected.

[1] For the purposes of this study, these persons were defined as those who had visited Maine one or more times in the past three years.

[2] NCHRP Report 187, "Quick-Response Urban Travel Estimation Techniques and Transferable Parameters," Transportation Research Board, 1978, and NCHRP Report 365, "Travel Estimation Techniques for Urban Planning," Transportation Research Board, 1998.

The on-site survey had two main purposes:

- To define the market of travelers, by providing demographic and trip characteristics
- To elicit opinions from existing Bar Harbor visitors about different possible travel options.

The second survey was a mail-out survey to residents from outside of Maine who had recently requested tourist information from the Maine Office of Tourism. Nine hundred and fifty surveys were mailed out and 238 usable surveys were returned. The major purpose of this survey was to gauge the degree that different car-free transportation options could induce new tourist visits to Maine and, in particular, to Bangor, Bar Harbor, and elsewhere on Mount Desert Island.

Both surveys used "stated preference" techniques to test alternative transportation options. For the current study, the uniqueness of the proposed services and the lack of comparable alternatives to the proposed new services made stated preference the only practical approach for evaluating the range of alternatives. Survey respondents collectively evaluated 23 different travel scenarios (21 for the intercept survey and 2 for the mail-out), each of which had different combinations of modes (rail, bus, or ferry), trip frequencies, travel times, and cost. The combinations followed a carefully constructed "experimental design," which permitted the determination of the specific effects of each factor--mode, frequency, cost, etc.-- that could influence the choice to use a proposed new mode.

For both surveys, ordered probit was used to analyze the data. This is a statistical technique that is similar to regression analysis in that seeks to identify a "best fit" mathematical formula to explain the relationship between a range of independent variables and some other variable (the dependent variable). For this study, the dependent variable was presented in one of five distinct values from 1 ("very likely") to 5 ("very unlikely").

While the surveys used narrative and graphic descriptions to present respondents with a clear, realistic set of situations, the survey data also represented statements of choices in response to hypothetical choices. This introduces the potential for respondents to exaggerate their true intent compared to what they would really do if faced with similar choices in real life. To deal with this, the analysis included a series of logic checks and a review of the respondents' actual (revealed) travel behavior on their existing trip to Bar Harbor. The results are logical and reasonable, and minimize the effect of "non-commitment" bias.

Visitor Mode Shift Forecasts

The visitor mode shift forecasting process consisted of three steps:

1. Designing and conducting an on-site survey of Mount Desert Island visitors.
2. Analysis of the survey data and model design.
3. Development of ridership forecasts.

Survey Design and Process

In mid-July of this year, the study team conducted an intercept survey and collected completed questionnaires from 1,581 visitors to Mount Desert Island. Each self-completed questionnaire asked about the demographics of the people traveling with the respondent, the characteristics of the trip to Mount Desert Island, and the respondent's interest in a hypothetical transportation scenario for the Bangor to Trenton corridor. There were 21 different versions of the survey, each handed out

sequentially, and each testing a different scenario. Technically, the structure for the 21 versions was a "fractional factorial" design with orthogonality in regard to main effects. In other words, the scenarios in each survey version had particular combinations of mode, travel time, need for a transfer, frequency, and cost for some hypothetical service. By examining the survey responses to each of these experimental designs, it was possible to gauge how each factor (travel time, mode, etc.) would contribute to travel demand. Table 1 summarizes the differences among the 21 survey versions, and sample survey forms are attached.

Each version of the survey had a brief narrative description of the proposed transportation alternative and also presented a map of the route and a photograph of how the mode would likely look. The goal of this presentation was for survey respondents to have an understanding of the proposed service that was realistic and as clear as possible.

Table 1
Survey Variations

Version	Mode	Rail Direct to Bangor	Trip Time	Service Frequency	Fare
1	Rail	Yes	75	60	$5
2	Rail	Yes	85	90	$20
3	Rail	No	95	120	$10
4	Rail	No	85	90	$10
5	Rail	No	75	90	$10
6	Rail	No	85	60	$10
7	Rail	Yes	95	90	$20
8	Rail	Yes	85	120	$5
9	Busway	--	65	120	$20
10	Bus	--	75	90	$5
11	Bus	--	85	60	$10
12	Bus	--	75	90	$10
13	Busway	--	65	60	$10
14	Bus	--	75	120	$10
15	Bus	--	85	60	$5
16	Bus	--	75	60	$20
17	Ferry	--	195	60	$10
18	Ferry	--	195	60	$20
19	Ferry	--	195	120	$10
20	Ferry	--	195	120	$20
21	Ferry	--	195	180	$10

Survey Data Analysis and Model Design

For each of the survey scenarios, the respondent was asked to state his or her likelihood to do the following:

- Fly to Bangor and take the new service to Trenton or Bar Harbor;
- Take the bus to Bangor and then the new service to Trenton or Bar Harbor;
- Drive to Bangor or Brewer and take the new service to Trenton or Bar Harbor;

- Drive to Ellsworth and the take the new service to Trenton (except not asked for the ferry alternatives); and,
- Drive to Mount Desert Island, but take the new service for visits to Bangor or Ellsworth.

There were the five parts of question 12 on the survey, and for each part, the likelihood rating was on a five point scale from 1 (very likely) to 5 (very unlikely). The respondent could also check a box for "don't know" (see Table 2).

Table 2
Unadjusted Survey Responses: Question 12

	1 (Very Likely)	2	3	4	5 (Very Unlikely)	Don't Know
Fly to Bangor and then use new Service	7.7%	5.1%	6.8%	6.3%	56.5%	17.5%
Bus to Bangor and then use new service	3.1%	2.4%	5.3%	7.2%	63.0%	18.9%
Drive to Bangor and then use new service	5.4%	5.9%	11.4%	9.0%	50.2%	18.1%
Drive to Ellsworth and then use new service	4.1%	7.9%	9.7%	9.7%	49.5%	19.1%
Drive to Bar Harbor but use new service for side trips	7.6%	6.7%	10.0%	9.3%	47.9%	18.6%

Note that the choices were designed to be mutually exclusive: the respondent could not be "very likely" to take the new service after flying to Bangor *and* be "very likely" to take the new service after driving to Bangor. However, many respondents made what seemed to be this inherent contradiction. To deal with this, responses were analyzed in two stages. First, each respondent's stated likelihood to use the new service was examined based on the highest likelihood that he or she expressed for any of the five parts in question 12. Second, the access mode was estimated based on the relative stated likelihood to each of the five parts of question 12. Thus, if someone responded "very likely" to Question 12a (fly to Bangor) *and* "very likely" to Question 12c (drive to Bangor), this person would be considered to be very likely to take the new service, with a 50% probability of getting to the new service by flying, and a 50% probability of getting to it by driving.

There was a small percentage of survey respondents who wrote "don't know" or did not respond to *all* of the parts to question 12. For these respondents it was assumed that they would ultimately let inertia prevail and that they would thus be "very unlikely" to use the service presented in the scenario.

While the intent was ultimately to aggregate ridership demand for the new transportation options, the aggregate demand is itself a reflection of individual decisions. Discrete choice models aim at understanding these individual decisions, and examined the weights on certain relevant, "deterministic" traits of the choices and of the individuals that most closely match the decisions made. In this analysis, the discrete choice technique was ordered probit.

The ordered probit models were applied to the surveyed individuals' stated likelihood to use the transportation service presented in the survey scenario. Here, the deterministic elements of the model

include the mode, travel time, fare, and frequency of the scenario; and the age, trip purpose, origin, existing mode, and other characteristics of the individual. The probit model assumes that these attributes, once weighted in a way that reflects their significance to the decision making process, can be added to define a single, net "utility" for each particular index of likelihood—1 (very likely) to 5 (very unlikely). Then, the probability that the dependent variable Y for respondent i falls into the jth category is given by:

$$\text{Prob}(Y_i=j) = \phi(\mu_j - \beta'\chi_i) - \phi(\mu_{j+1} - \beta'\chi_i)$$

Here, μ_j and μ_{j+1} are the upper and lower threshold values for category j. The ϕ refers to the cumulative normal distribution of the term within the parentheses. This is comparable to the logistic function used in logit models. Finally, the β' term refers to the set of coefficients or weights applied to the set of independent variables χ_i.

Note that the set of β's is really the key to the effectiveness of the model. This set of coefficients represents the specific weights that provide the "best fit" to the survey data. The project team derived these weights by evaluating the survey data using the maximum likelihood estimation procedures in the computer package SST.

Note too that the survey responses were examined by testing a variety of different segmentations and forms of the variables. The key segmentation was by mode. Here, the assumption was that travel in the corridor by ferry was so different from what it would be by bus or rail that travelers would have a totally different attitude about travel time and other attributes applied to one mode or the other. Also, while separate specifications were tested for rail and bus scenarios, the weights derived for key service attributes were not statistically different between the two modes, and the segmentation was dropped.

With regard to functional form of the variables, linear, exponential, and several combination forms of the variables were tested in each of the probit models. Alternative forms are appropriate when there is reason to believe that travelers would view the variables in other than a linear way. Travel time, for example, might have a non-linear effect—the traveler might become particularly unwilling to use the new mode when travel time gets beyond a certain threshold. The same might apply to fare. Demand for the new service at $10 may be 25 percent less than demand at $5, but it may be drop to near 0 (a non-linear relation) with the fare set at $20.

However, most of the alternative forms did not have the effect expected. Few of the forms added significantly to the predictive power of the models, but in those cases where it did improve the model statistically, it also made the interpretation of the results more confusing. This led to the conclusion that the added gains in most cases were not worth this cost of clarity. The variable transformations that were used involved mostly the questions on the survey about traveler attitudes. The survey asked (Question 11) the extent to which the respondent agreed with a set of statements about his or her travel experiences in Maine and on Mount Desert Island. The survey allowed the respondent to express the level of agreement on a 1 to 5 scale. These attitudinal variables were found to provide stronger results by including them as simply 1 (agreed strongly) or 0 (did not).

The on-site surveys also asked respondents to state their level of agreement with a question about whether the Island Explorer bus service was a good way to get around the island. Just over half of the respondents (51 percent) had any opinion at all about this service. The remainder either left the section blank or checked the box for "don't know." This variable had its strongest impact on the model when transformed as 1 (knew about Island Explorer and had an opinion) or 0 (did not).

After determining each form of the variable and the overall model segmentation, a two step estimation process was conducted. First, about 20 outlying observations were removed from each of the models. This was an iterative process: estimate the "best fit" probit equation, remove the one percent of observations with the greatest deviation from the expected results, and re-estimate the model with the remaining 99 percent of the data. This was done up to ten times. Note that less than half of these removed observations were people who said they were "very likely" to take the new service. Rather, the removed variables are the ones that are least consistent with the vast majority of the respondents--after accounting for all demographic and trip characteristics. Thus, the presumption is that these were the observations that reflected the least amount of thoughtfulness.

In the second step of the estimation process, variables with the most negligible effect on the stated likelihood of the respondents to use the new service were removed through an iterative process. This effect was measured statistically by the t-statistic. Dropping those variables from consideration in the model strengthened the effects of other variables and may be critical for cases of multi-collinearity, i.e., when two independent variables themselves tend to have their own correlation. In these cases, the effect of each variable on the stated likelihood to use the new service might *only* be visible by removing one of the two from the model.

The "best fit" model specifications and the descriptive statistics appear in Table 3. For both the bus/rail and the ferry segmentations, the results are logical. Variables which were expected to be statistically significant generally are significant, the signs are in the right direction, and the relative values among the independent variables are reasonable.

Table 3
Mode Shift Model Specifications

	Bus and Rail Options		Ferry Options	
	Estimated Coefficient	t-Statistic	Estimated Coefficient	t-Statistic
Resident: Maine			0.3599	1.6
Resident: Other New England				
Resident: Canada	0.6229	2.0		
Resident: Other International			0.5930	1.2
Purpose: Visit Family, Friends	-0.3551	-2.4	-0.5192	-1.9
Purpose: Business			-1.4225	-2.9
Group: Alone Or Couple			-0.1703	-1.2
Pet				
Group Size				
Age Group: Oldest	0.0333	2.2		
Age Group: Youngest	0.0140	1.2		
Visit Only Bar Harbor	-0.1905	-2.1	-0.2378	-1.4
Visit Bangor	-0.3411	-3.0	-0.4164	-2.0
Days On Bar Harbor	-0.0304	-3.9	-0.0356	-2.8
Overnight: None	-0.3320	-2.8	0.3026	1.3
Overnight: Bar Harbor			0.3225	1.7
Overnight: Ellsworth	-0.3412	-2.1	0.4866	1.5
Overnight: Bangor				
How Get: Drive No Trailer	-0.1664	-1.0	0.3783	1.3
How Get: Drive With Trailer	0.2535	1.2	1.0721	2.6
How Get: Flew	-0.4422	-2.5	-0.3432	-1.0
Route: I-95 To Bangor			-0.3000	-1.9
Route: Other Route	0.6295	3.0		
Q11: Car Only Way For Trip	0.3385	3.6		
Q11: Need Car On Bar Harbor	0.5902	5.3	0.4930	2.6
Q11: Car For Luggage	0.1608	1.6	0.2172	1.2
Q11: Car Cheapest	-0.1043	-1.1		
Q11: Congestion In Maine				
Q11: Congestion To Maine				
Q11: Drive Part Of Pleasure				
Q11: Island Explorer	-0.3912	-4.6		
New Mode Travel Time	0.0035	3.4		
New Mode Frequency	0.0041			
New Mode Cost	0.0155		0.0419	2.8
New Mode To BGR	-0.2400	-1.8		
Bus Mode (Add To Constant)	0.1547	1.3		
Constant	1.1850	3.8	1.6151	4.1
Thresh 1	0.6269		0.7200	
Thresh 2	1.1605		1.5398	
Thresh 3	1.4665		1.9922	
Auxiliary Statistics				
Initial Log	-1769.50		-583.32	
Converge Log	-983.51		-293.25	
Rho Bar Squared	0.43		0.47	

Development of Ridership Forecasts

The choice models developed in prior steps predict *individual* likelihood of survey respondents to use the new service presented in the survey scenarios. Estimates of demand for the proposed alternatives in the Bangor to Trenton corridor require predictions of *aggregate* behavior. There are several techniques available for performing this aggregation and making predictions for the larger population. The projections and calculations here are based on applying the coefficients estimated in the models to the survey sample with the attributes of the scenarios replaced by the attributes (mode, travel time, frequency, etc.) of the particular proposed alternative. Sample enumeration is then used to determine the predicted share of the sample choosing each level of likelihood of use. The mathematical representation of the sample enumeration technique is as follows:

$$\hat{W}(i) = \frac{1}{N_s} \sum_{n=1}^{N_s} P(i \mid x_n)$$

where:

$W(i)$	=	the predicted share of the sample choosing likelihood i;
x_n	=	a matrix of all the attributes in the deterministic part of the model that affect the individual's stated likelihood;
$P(i\|x_n)$	=	the probability of having likelihood level i given x_n.

The final step is then to translate the stated expression of "likelihood" into an estimate of actual use. In other words, just how likely is "very likely"? Note that this raises a complication of non-commitment bias; i.e., the tendency of some people to exaggerate their intentions beyond what they would truly do if faced with similar conditions in reality.

To a limited extent it was possible to get some sense of the non-commitment bias by comparing the stated likelihood to use a car-free alternative against actual experience of the survey respondents with an existing comparable mode. The relevant actual choice is the number of survey respondents who flew to Bangor and took the existing bus service to Bar Harbor. This bus service is not entirely comparable because it only runs four times per day, has a one-way cost of $22 (beyond what we tested in the survey), and requires a reservation 24 hours in advance. The scenarios in the survey did not require a reservation.

In making this test, the stated preference coefficients were applied to the travel time, headway, and fare of the existing service, and then adjusted the alternative specific constants to match the actual daily boardings. Assumption were also required about the number of the actual boardings that were by recreational travelers, and about the "disutility" of having to make a reservation for the service.

Using the initial bus/rail stated preference model, the existing service configuration for the Bangor to Bar Harbor bus was predicted to carry 150 of the 19,000 daily recreational visitors trips to Bar Harbor. This assumed that there is no disutility with making a reservation. In fact, by knowing the maximum capacity of 12 seats (it is a van, not a bus), we could simply derive a disutility for reservations as the value needed to cut the 150 down to 96 (4 trips x 12 seats x 2 round trips).

In any case, at 96 seats for 19,000 daily recreational visitors, it would have been expected that 5 of the 1,581 survey respondents would have used the Concord Trailways service. Forty-two respondents who flew to Bangor, 29 rented a car and 13 got picked up—none took the Concord Trailways van. Moreover, we can be 95 percent confident that the true mean for the sample would be between 0 and 1 would take the existing van--the estimate of five is outside the range. This suggests that there is in fact a fair degree of non-commitment bias in the survey sample. Only by setting the stated "very likely" to an actual rate of 33 percent, could we match the expected level of Concord Trailways ridership. This was fairly conservative, as we assumed that the need for a reservation was in fact not a disutility to use of this bus. Had we assumed that the reservation was a real impediment, the value assigned to "very likely" would have had to be lower. The values assigned to the other stated probabilities were proportionately lower than that assigned to "very likely."

This process resulted in the predicted usage levels for the new services shown in Table 4. These figures represent the share of current visitors that would use the new services. These shares were then aggregated to produce a total predicted mode shift for each alternative that was then applied to the total predicted 2020 peak summer daily travel volume of 19,000 one-way trips.

Table 4
Percent of Current Visitors Who Would Use Bangor – Bar Harbor Transit Service

Current Access Mode	Percent of Current Visitors	Projected Mode Share					
		Alt 1 Rail/Bus	Alt 2 Bus	Alt 3 Busway Bypass	Alt 4 LRT A	Alt 5 LRT B	Alt 6 Ferry
Drive w/o Trailer	68.5%	3.0%	3.4%	3.7%	4.3%	4.1%	3.5%
Drive RV or w/trailer[3]	10.0%	1.9%	2.2%	2.4%	2.9%	2.7%	1.4%
Fly to Bangor	2.8%	4.4%	4.9%	5.2%	6.1%	5.8%	11.3%
Fly to Other Airport	16.4%	4.7%	5.2%	5.6%	6.4%	6.1%	8.4%
Total	100.0%	3.2%	3.6%	3.9%	4.6%	4.4%	4.6%

Visitor Induced Demand

The visitor induced demand forecasting process was developed to project the number of new trips to the Mount Desert Island area that would be attracted by new Bangor – Bar Harbor services. In other words: will the new services encourage existing visitors to make new trips than they would otherwise, and would they attract new visitors that other wise would not come to the area?

These forecasts were produced in a similar manner as the visitor mode shift forecasts, through a three part process that consisted of (1) designing and conducting a survey, (2) analyzing the survey data and developing a forecasting model, and (3) running the model to develop forecasts.

Survey Design and Process

To determine induced demand, a mail-out survey was conducted of visitors who had requested information from the Maine Office of Tourism over the past year. This survey, a version of which is

[3] Most of these visitors would still drive to the Bar Harbor area but would use corridor services for local travel and side trips.

shown in Attachment A6, was designed to determine whether those "potential visitors" did actually visit Maine, and whether or not their choice would have been different if Bangor – Bar Harbor services had been available.

This mail-back survey was distributed to 950 people from outside Maine. These individuals all had an awareness of Maine (since they had requested information), but had not necessarily been to Bar Harbor, or anywhere else in the state. Each mailed-out survey presented the State-wide network of proposed transportation investments, and highlighted the rail service proposed for the Bangor to Trenton corridor. Half the surveys defined the corridor rail service as running hourly at a one-way cost of $5. The other half had the service running every two hours at a one-way cost of $10.

Survey Analysis and Model Development

The analysis of survey data involved the estimation of a "best fit" model to reflect the stated willingness of the respondents to take added trips (including a first trip) to Maine and Bar Harbor. This method was very similar as for the mode-shift model, and produced the model specifications presented in Table 5.

Ridership Forecasts

Additional Trips By Current Visitors

Based on the analysis of the mail-back survey data, and a similar methodology as for the mode shift estimates, it was estimated that 4.2% of visitors would take some new trips to the region because of the proposed transportation service.

To convert this into a number of expected new trips by *existing* visitors, the 4.2% was applied to the 1,063,695 visitors currently estimated to arrive annually at Bar Harbor. This yields 44,568 annual travelers who would take some new trips. Survey data also revealed that the average visitor to Bar Harbor takes 0.49 trips to Bar Harbor each year. By assuming that each of these travelers would increase their Bar Harbor trip making by 25 percent, the number of annual new trips by existing travelers to the region would be 5,476 (44,568 travelers * 0.49 trips per person per year * 0.25 increased trips). The peak annual day for visitors is currently 0.0067 of the total annual visitor travel, and this is equivalent to 37 daily travelers, or 74 daily one-way trips in 2000. Expanding this number by 17.8% to represent the growth in total annual travel between 2000 and the forecast year of 2020, yields an estimate of 87 induced daily trips. As these trips are induced by the new transportation service, it was assumed that each new trip would use the new service.

Table 5
Induced Demand Model Specifications

	Estimated Coefficient	t-Statistic
Resident: New York	0.639	2.7
Resident: Canada	0.440	1.2
Been to Bar Harbor	-0.451	-2.1
Been to Bangor		
Been Elsewhere in Maine		
Plan to visit Maine in next year	0.275	1.4
Q7a: Car Only Way For Trip		
Q7b: Need Car On Bar Harbor		
Q7c: Car For Luggage	0.675	3.1
Q7d: Car Cheapest	0.461	2.0
Q7e: Maine part of longer trip		
Q7f: Traffic fairly smooth in Maine	-1.189	-4.4
Q7g: Drive Part Of Pleasure	0.616	2.7
Version		
Couple		
Oldest	-0.016	-2.0
Youngest	0.016	3.1
Own car	-0.919	-2.2
Constant	2.395	3.5
Thresh 1	0.244	2.1
Thresh 2	1.631	15.6
Thresh 3	2.289	20.4
Auxiliary statistics		
Initial log	-280.71	
Converge log	-152.84	
Rho bar squared	0.46	

Finally, the transportation alternative presented in the mail-out surveys was essentially the same as Alternative 4/LRT A. Therefore, the estimate of 87 induced additional trips per day reflected effectively ridership on Alternative 4. For the other alternatives, it was presumed that the relative attractiveness of the various alternatives to induced visitors would be the same as indicated by current visitors. On this basis, the 87 trips per day figure was factored up or down for the other alternatives based on differences in the visitor mode shift estimates.

New Trips by New Visitors

While the new service would induce some visitors to take *additional* trips to Maine and Bar Harbor, it would also induce some visitors who had never been to Maine to take their *first* trip to the region. Given that these travelers came to the region because of the new transportation service, it is fair to assume that they would also take the new mode.

A key component of this estimate is the size of the potential market of people who have never been to Maine, but would conceivably be interested in going. It is unreasonable to consider this a boundless number. Rather, the mail-out survey suggests a more binding approach. According to this survey, 37.5% of the survey respondents had visited the Bar Harbor area in the last three years, and 33% of people had not been to the state. However, not all of the respondents who did not go to Maine would have gone to Bar Harbor had they visited. Based on past surveys by Longwoods, approximately 20 percent of visitors to Maine go to Bar Harbor. This suggests that 6.6 percent of the survey respondents who ultimately did not go to Maine were interested in visiting Bar Harbor (33 percent * 20 percent).

Comparing the 37.5% of respondents who actually visited Bar Harbor to the 6.6% who did not indicates that for every 100 actual visitors, approximately 18 people seriously considered a visit, but ultimately did not make the trip (6.6% divided by 37.5%). Compared to current visitation levels of 1,063,695 visitors per year, this indicates that a total 187,113 additional individuals who seriously considered visiting Bar Harbor but did not. This figure was used as the size of the potential market of people for whom the new service could induce first trips to the region.

How many of these potential travelers would come because of the new service? Analyzing the survey responses suggests that 4.86 percent of these travelers would make the trip. This is 9,094 trips on an annual basis, or 122 trips on a peak summer day in 2000. Factoring this number up by 17.8 percent to represent background growth would yield 144 induced visits during a peak summer day in the 2020 forecast year.

Finally, as described above, the transportation alternative presented in the mail-out surveys was essentially the same as Alternative 4/LRT A. Therefore, the estimate of 144 induced new trips per day reflected effectively ridership on Alternative 4. For the other alternatives, it was presumed that the relative attractiveness of the various alternatives to induced visitors would be the same as indicated by current visitors. On this basis, the 144 trips per day figure was factored up or down for the other alternatives based on differences in the visitor mode shift estimates.

RESIDENT FORECASTS

Forecasts of resident travel were estimated using quick-response travel estimation techniques described in National Cooperative Highway Research Program (HCHRP) reports 187 and 365.[4] The overall method is a simplified version of traditional four-step transportation modeling, which uses transferable model parameters from other small urban areas in cases where specific data was not available for the Bangor – Bar Harbor corridor. This methodology is summarized below and described in the following sections.

Trip Generation produces estimates of the numbers of trips generated in and attracted to the Bangor – Bar Harbor corridor. Trips "produced" in the corridor represent trips made by residents of the corridor. Trips "attracted" to the corridor are those made to "attractions" in the area such as jobs, stores, services, and visits to friends and family. Estimates of the numbers of trips produced and attracted were developed in terms of home-based work trips (trips between home

[4] NCHRP Report 187, "Quick-Response Urban Travel Estimation Techniques and Transferable Parameters, Transportation Research Board, 1978, and NCHRP Report 365, "Travel Estimation Techniques for Urban Planning, Transportation Research Board, 1998.

and work, in either direction), home-based other trips (all other trips with one end at home), and non-home-based trips (trips where neither end is at home).

Trip Distribution links the "generated" trips with the "attracted" trips on a zone-by -zone basis. The most critical factors for trip distribution are trip length and the orientation of travel (for example, suburb-to-suburb, or suburb-to-Central Business District), with trips distributed using a gravity model. The gravity model distributes trips on the basis that the number of trips between zones will be directly proportional to the number of trip ends in each zone (in terms of productions and attractions), and inversely proportional to the travel times between zones. For the purposes of these forecasts, and in consideration of the level of detail at which necessary information was available, estimates were produced on a town-by-town basis.

Mode Choice splits the total zone-to-zone person trips resulting from the trip distribution model into trips using each available mode between the zone pair; in this case, either automobile or transit. The forecasts presented herein were developed using a logit model which splits trips between modes on the basis of travel time and travel cost.

Trip Assignment assigns trips to specific roadways and transit services. For these forecasts, all corridor transit trips were assigned to proposed Bangor – Trenton transit services (since this would be the only corridor transit option available), except for trips between Brewer and Bangor, which were split between Bangor – Trenton services, and Bangor's The Bus, which provides bus service between Brewer and Bangor.

Trip Generation

Estimates were developed for the number of trips produced in the corridor and attracted to the corridor for home-based work (HBW) trips, home-based-other (HBO) trips, and non-home-based (NHB) trips. These estimates were developed using corridor specific data where available, and transferable parameters from other small urban areas in cases were Bangor – Bar Harbor corridor data was not available. Estimates were initially developed for Summer 2000 and then expanded to Summer 2020.

Trip Productions

Trip productions are driven by a number of factors, the most important of which are the number of households in an area, income levels, and automobile ownership levels. Based on these factors, the number of trips can be estimated using trip rates derived from home interview surveys conducted since 1985 and from the 1995 National Personal Transportation Survey. As would be expected, the number of trips made per household increases with household size and the number of automobiles available—from only 2.6 trips per day for a one person household with no car available, to over 13 trips per day for a 5 or more person household with three or more automobiles.

Trip purposes also vary by household size, with smaller households making a greater percentage of trips for work, and fewer for other purposes. By household size, the percentage of work trips generally varies from 17% to 20%, the percentage of "home-based other" trip (trips to or from home for shopping, recreations, etc.) ranges from 54% to 62%, and for "non-home-based" trips (trips with neither end at home, such as running a lunch time errand from work) range from 21 to 26%.

Summer 2000

For Summer 2000, home-based work trips were estimated as described in the document "Description of the Current Resident Travel Market in the Bangor – Trenton Corridor." These estimates take into account work trips made by year-round residents, as well as by those made by seasonal workers who move to the area for the summer. In summary, this was done as follows:

1. On an origin town by origin town basis, the number of 1990 journey-to-work trips was expanded by the percentage increase in the number of employed residents over the period 1990 to 2000. This approach assumes that the percentage of employed residents who worked outside of the home stayed the same over this period.
2. Seasonal employees were assumed to all work outside of the home.
3. Expansion factors were developed on an home town-by-home town basis that represent the difference between 1990 year-round employed residents and Summer 2000 employed resident levels. These calculations indicate that Summer 2000 employment levels are 8.9% higher than year-round 1990 employment levels in the Bangor area towns, and 40.9% higher in the coastal communities.
4. The home town-by-home town expansion factors were applied to the 1990 Journey-to-Work figures to produce an estimate of the number of Summer 2000 Journey-to-Work trips originating in each town. Since these trips represent round trips, these figures were then multiplied by 2 to represent the number of trips produced in each town. These summer 2000 figures are shown in Table 9. In total, for the summer of 2000, approximately 61,000 home-based work trips were made per day.

Table 9
Summer 2000 Trip Productions by Town

	HBW	HBO	NHB	Total
Bangor	29,147	64,474	27,334	120,954
Brewer	7,860	19,332	8,133	35,325
Holden	3,018	6,781	2,803	12,602
Dedham	1,115	4,183	1,733	7,030
Ellsworth	8,391	14,050	5,911	28,353
Lamoine	1,484	3,525	1,478	6,487
Trenton	1,675	2,831	1,195	5,701
Bar Harbor	7,070	10,071	4,271	21,411
Mount Desert	2,911	5,606	2,389	10,906
Southwest Harbor	3,000	4,835	2,043	9,877
Tremont	1,704	3,853	1,633	7,190
Total	**67,375**	139,541	58,923	**265,838**

Source: KKO calculations and NCHRP Report 365 methodologies

For the estimation of non-work trip productions, general information is now available from the 2000 US Census for full-time residents on a town-by-town basis for total population, the number of households, and average household sizes. However, the census data does not include any information on seasonal residents. For these forecasts, the number of summer residents was estimated based on the number of seasonal residences and assumed rates of use, and the number of seasonal employees, and resulting trip rates represent trips made by both year-round and seasonal residents.

Also, while some 2000 US Census data is available, detailed breakdowns for most data elements, including household size are not yet available. In the absence of this detailed data, it was assumed that the proportions of one, two, three, and four plus persons household stayed the same from 1990 to 2000, and that the numbers of automobiles owned has also remained similar.[5]

Using the estimates of the number of full time and seasonal residents, the assumptions described above, and applying the trip rates from NCHRP Report 365, resulted in estimates of summer 2000 trip productions as presented above in Table 9. In summary, there are a total of 140,000 home-based-other trips per day, and 59,000 non-home based trips. In total, including the home-based work trips, full and part time residents of the corridor made 266,000 trips per day in the summer of 2000.

Summer 2020

Summer 2020 trip productions were estimated based on projected increases in population and employment increases through 2020. These projections required the use of a number of assumptions:

> **Population**: The Maine State Planning Office has produced projections of population growth on a county-by-county basis through 2010. These projections indicate that population will grow by an average annual rate of 0.2% in Penobscot County (which includes Bangor, Brewer, Dedham, and Holden), and by 0.9% in Hancock County (which includes the remainder of the corridor towns). These county rates of growth were assumed to be reasonable estimates for population increase for the foreseeable future and were applied on a town-by-town basis for the period 2000 through 2020 to produce 2020 population estimates (see Table 10).

[5] This is almost certainly <u>not</u> the case, as 2000 US Census data indicates that household sizes have declined. However, at the same time, auto ownership rates have likely been increasing. As a result, in the absence of a basis to adjust the 1990 figures, it was assumed that the impact of declining household sizes has been offset by the impact of higher automobile ownership rates.

Table 10
Projected 2020 Population

	2000 Population[a]	Projected Increase to 2020[b]	Estimated 2020 Population
Bangor	31,473	0.2%	32,498
Brewer	8,987	0.2%	9,280
Holden	2,827	0.2%	2,919
Dedham	1,238	0.2%	1,278
Ellsworth	6,456	0.9%	7,744
Lamoine	1,381	0.9%	1,657
Trenton	1,370	0.9%	1,643
Bar Harbor	4,820	0.9%	5,782
Mount Desert	2,109	0.9%	2,530
Southwest Harbor	1,966	0.9%	2,358
Tremont	1,375	0.9%	1,649
Total	64,002		69,338

Sources: (a) 2000 US Census; (b) Maine State Planning Office County-by-County projections, 2000 to 2010.

Employment: No state or regional agencies produce projections of employment growth for Bangor – Trenton corridor towns. Only historical data is available, and the only town-by-town data that is available is 1990 US Bureau of Labor Statistics data.[6] Therefore, to estimate 2020 employment, 1990 employment by town was expanded to 2000 using the rate of growth in employed residents. Growth in employment over this period—14.5%— was very high and included increases in the proportions of residents choosing to work. Also, summer 2000 employment levels represented some of the lowest unemployment levels ever experienced in the United States, and generally represented "full employment," meaning that nearly every resident who wanted to work was working. Since neither large increases in labor force participation nor lower unemployment levels are likely, it was assumed that for 2020, labor market participation rates would be the same as in 2000. On this basis, factors were developed to relate 2000 employment and population levels, and these factors were then applied to the 2020 population projections to produce 2020 employment projections (see Table 11).

[6] All Maine Department of Labor town-by-town data is on the basis of residents in each town that are employed, rather than the number of jobs in each town.

Table 11
Projected 2020 Employment

	July 1990 Jobs	Employed Resident Growth '90-00	July 2000 Jobs	Jobs/ Resident	2020 Residents	July 2020 Jobs
Bangor	30,535	12.40%	34,317	1.1	32,498	35,435
Brewer	4,896	11.50%	5,458	0.6	9,280	5,636
Holden	328	19.20%	391	0.1	2,919	404
Dedham	111	10.50%	123	0.1	1,278	127
Ellsworth	4,998	21.90%	6,094	0.9	7,744	7,310
Lamoine	123	23.60%	152	0.1	1,657	182
Trenton	312	30.10%	406	0.3	1,643	487
Bar Harbor	2,971	19.70%	3,558	0.7	5,782	4,268
Mount Desert	692	22.50%	848	0.4	2,530	1,017
Southwest Harbor	1,078	25.00%	1,348	0.7	2,358	1,617
Tremont	128	23.40%	158	0.1	1,649	190
Total	46,172		52,852	0.8	69,338	56,672

On this basis, in which population and employment growth rates are assumed to be similar, 2000 trip productions were expanded to 2020 trip productions on the basis on population growth by town. These 2000 trip production estimates, which are shown in Table 12, project that the number of trip productions in the corridor with increase by 7.4% between 2000 and 2020 to a total of 278,000 trips per day.

Trip Attractions

Trip attraction rates are based on the number households and type of jobs (retail, service, or other) in an area, and whether or not the jobs are located in the central business district (CBD) or outside of the CBD, using the following formulae:

*HBW Attractions = 1.45 * Total Employment*
*HBO Attractions CBD = 2.0 * CBD RE + 1.7 * SE + 0.5 * OE + 0.9 * HH*
*HBO Attractions non-CBD = 9.0 * non CBD RE + 1.7 * SE + 0.5 * OE + 0.9 * HH*
*NHB Attractions CBD = 1.4 * CBD RE + 1.2 * SE + 0.5 * OE + 0.5 * HH*
*NHB Attractions non-CBD = 4.1 * CBD RE + 1.2 * SE + 0.5 * OE + 0.5 * HH*

HBW - Home Based Work trips
HBO - Home Based Other Work trips
NHB - Non Home Based trips

Table 12
2020 Trip Productions

	HBW	HBO	NHB	Total
Bangor	29,615	63,164	26,688	119,466
Brewer	7,984	19,239	8,059	35,282
Holden	3,066	6,550	2,696	12,311
Dedham	1,220	5,174	2,123	8,517
Ellsworth	9,189	16,180	6,772	32,141
Lamoine	1,624	4,161	1,731	7,516
Trenton	1,834	3,643	1,526	7,003
Bar Harbor	7,741	11,765	4,964	24,469
Mount Desert	3,187	6,469	2,746	12,402
Southwest Harbor	3,284	5,283	2,225	10,792
Tremont	1,865	4,573	1,925	8,363
Total	70,608	146,200	61,455	278,263

Source: KKO calculations and NCHRP Report 365 methodologies

Where:
CBD RE = Retail employment in the CBD
Non-CBD RE = Retail employment outside of the CBD
SE = Service employment
OE = Other employment
HH =Households

Summer 2000

As described above, only limited employment data is available for the Bangor – Trenton corridor, and the only recent data on employment type is 1999 US Bureau of Labor Statistics data on a county-by-country data. To estimate trip attractions, proportions were assumed to have remained stable through 2000, and these proportions were applied to the estimated number of jobs in each town in 2000. Bangor was assumed to generally represent the CBD, and all other towns were classified as non-CBD. The number of households was as reported in the US Census, plus the estimate of seasonal households described in the Resident Market document.

Finally, estimates of trip attractions were balanced with trip productions. This was done by scaling trip attractions up or down to match trip production totals by trip purpose. The resulting Summer 2000 trip attraction estimates are as shown in Table 13, with trip attractions matching trip productions at 259,000 per day.

Summer 2020

Summer 2020 trip attractions were estimated based on the projected 2020 employment levels described in the previous section, and based on the assumption that 2020 employment, by type, would remain proportionally similar as in 2000. The number of households was projected to increase at the same rate as total population. On this basis, total trip attractions were projected to increase by 7.4% from 2000 to 2020, to a total of 278,300 per day (see Table 14).

Table 13
Summer 2000 Trip Attractions

	HBW	HBO	NHB	Total
Bangor	39,461	65,578	30,822	135,861
Brewer	6,276	21,826	8,315	36,417
Holden	449	2,402	939	3,791
Dedham	141	1,012	399	1,552
Ellsworth	7,007	22,287	8,398	37,692
Lamoine	175	1,034	405	1,614
Trenton	467	1,775	678	2,920
Bar Harbor	4,091	13,400	5,061	22,552
Mount Desert	975	3,787	1,449	6,210
Southwest Harbor	1,550	5,295	2,007	8,852
Tremont	182	1,145	450	1,776
otal	60,773	139,541	58,923	259,237

Source: KKO calculations and NCHRP Report 365 methodologies

Table 14
Summer 2020 Trip Attractions

	HBW	HBO	NHB	Total
Bangor	44,149	65,292	30,724	140,165
Brewer	7,022	21,743	8,289	37,053
Holden	503	2,383	931	3,817
Dedham	158	1,049	415	1,622
Ellsworth	9,107	25,609	9,649	44,366
Lamoine	227	1,145	448	1,820
Trenton	607	2,013	768	3,388
Bar Harbor	5,317	15,362	5,802	26,482
Mount Desert	1,267	4,290	1,640	7,197
Southwest Harbor	2,015	6,051	2,292	10,358
Tremont	236	1,265	496	1,997
Total	70,608	146,200	61,455	278,263

Source: KKO calculations and NCHRP Report 365 methodologies

Trip Distribution

Once the number of trips produced and attracted by each zone had been estimated, trips were distributed between production and attraction interchanges. This was done using a gravity model, which is the most common methodology used in transportation planning. The gravity model predicts that the relative number of trips made between two geographical areas will be directly proportional to the number of productions and attractions in each zone, and inversely proportional to the travel time between zones. In simpler terms, the gravity model predicts that trips will tend to be made to closer destinations than to those farther away (for example, people are more likely to shop at a supermarket

closer to home than one farther away). Mathematically, the gravity model for trip distribution is as follows:

$$T_{ij} = P_i \left(\frac{A_j F_{ij}}{\sum_{k=1}^{zones} A_k F_{ik}} \right)$$

where:
T_{ij} = the number of trips from zone I to zone j
P_i = the number of trips produced in zone I
A_j = the number of trip attractions in zone j
F_{ij} = the friction factor relating the spatial separation between zone I and zone j

The friction factor in the above equation is the primary independent variable and quantifies the measure of separation between zones in terms of travel times:

$$Fij = t_{ij}^{b} x e^{cxtij}$$

where:
Fij = the friction factor relating the spatial separation between zone I and zone j
Tij = the travel time between zones i and j
b = model coefficient with values of –0.020 for HBW trips, -1.285 for HBO trips, and –1.332 for NHB trips.
c = model coefficient with values of –0.123 for HBW trips, -0.094 for HBO trips, and –0.100 for NHB trips.

The travel times between zones were calculated based on average automobile travel times from town center to town center, as estimated by Street Atlas USA, which is a mapping and trip planning program. Added to these times were terminal times, which represent time spent to park, to walk to a car, etc. Terminal times were set a 4 minutes for Bangor, and 2 minutes for all other towns.

This application of the gravity model resulted in the 2020 trip table shown in Table 15. As can be seen in this table, there is a well defined split in corridor travel in terms of trip orientation. Most trips from the Bangor area towns (Bangor, Brewer, Holden, and Dedham) are oriented toward Bangor and Brewer, while trips from the coastal communities (Ellsworth, Lamoine, Trenton, and those on Mount Desert Island) are oriented toward the coastal area.

Table 15
2020 Trip Tables

From	To											
	Bangor	Brewer	Holden	Dedham	Ellsworth	Lamoine	Trenton	Bar Harbor	Mount Desert	Southwest Harbor	Tremont	Total
HBW Trips												
Bangor	26,324	3,063	133	16	75	1	1	1	0	1	0	29,615
Brewer	6,557	1,339	51	6	29	0	0	0	0	0	0	7,984
Holden	2,460	443	76	13	70	1	1	1	0	0	0	3,066
Dedham	923	166	41	24	63	1	1	1	0	0	0	1,220
Ellsworth	445	80	22	6	7,972	106	221	184	56	89	6	9,189
Lamoine	44	8	2	1	1,292	60	86	72	22	35	2	1,624
Trenton	38	7	2	1	1,090	35	174	267	82	130	9	1,834
Bar Harbor	18	4	1	0	570	18	168	5,766	835	339	24	7,741
Mount Desert	9	2	0	0	260	8	76	1,246	917	535	133	3,187
Southwest Harbor	11	2	0	0	303	10	89	371	392	1,931	176	3,284
Tremont	3	1	0	0	114	4	33	139	511	921	139	1,865
Total	44,149	7,022	503	158	9,107	227	607	5,317	1,267	2,015	236	70,608
HBO Trips												
Bangor	52,560	9,935	502	60	100	2	2	2	1	1	0	63,164
Brewer	12,439	6,470	251	29	47	1	1	1	0	0	0	19,239
Holden	3,921	1,567	808	111	134	2	3	2	1	1	0	6,550
Dedham	2,494	966	591	832	275	4	5	4	1	2	0	5,174
Ellsworth	128	48	22	8	15,292	214	255	109	40	56	7	16,180
Lamoine	29	11	5	2	3,216	460	253	96	35	49	6	4,161
Trenton	21	8	3	1	2,003	132	741	370	142	200	22	3,643
Bar Harbor	8	3	1	0	399	23	173	9,639	1,199	286	34	11,765
Mount Desert	4	1	0	0	175	10	80	1,439	3,517	685	557	6,469
Southwest Harbor	2	1	0	0	103	6	47	143	285	4,259	438	5,283
Tremont	1	0	0	0	65	4	27	87	1,189	2,246	954	4,573
Total	65,292	21,743	2,383	1,049	25,609	1,145	2,013	15,362	4,290	6,051	1,265	146,200
NHB Trips												
Bangor	23,036	3,433	171	19	27	0	1	0	0	0	0	26,688
Brewer	5,554	2,391	90	10	13	0	0	0	0	0	0	8,059
Holden	1,725	564	321	42	42	1	1	0	0	0	0	2,696
Dedham	1,091	345	236	356	90	1	2	1	0	0	0	2,123
Ellsworth	50	15	8	3	6,435	88	101	36	14	19	2	6,772
Lamoine	11	3	2	1	1,333	209	106	34	13	18	2	1,731
Trenton	8	2	1	0	831	58	335	145	57	80	9	1,526
Bar Harbor	3	1	0	0	140	9	68	4,124	499	107	13	4,964
Mount Desert	1	0	0	0	60	4	30	569	1,560	274	247	2,746
Southwest Harbor	1	0	0	0	34	2	17	49	110	1,823	188	2,225
Tremont	0	0	0	0	21	1	10	29	496	941	427	1,925
Total	30,724	8,289	931	415	9,649	448	768	5,802	1,640	2,292	496	61,455

Mode Choice

The trip patterns produced in the trip distribution step are important because they show that most of the trips that are made in the corridor would not be served by corridor transit services. For example, with a maximum of one station per community, trips within the same town would not be made by Bangor – Trenton service. Similarly, because there is no local transit service in the middle of the corridor, no trips would be made to communities such as Holden and Dedham that would not have stations. Finally, inter-community work trips made within Mount Desert Island would not utilize Bangor – Trenton services. The trips that could be made by transit using most of the Bangor – Trenton services, and connecting bus services included in most of the alternatives would be as shown in Table 16.

Table 16
Trip Interchanges that Could be Made by Bangor – Trenton Transit Services

	To										
From	Bangor	Brewer	Holden	Dedham	Ellsworth	Lamoine	Trenton	Bar Harbor	Mount Desert	SW Harbor	Tremont
Bangor	No	**Yes**	No	No	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**	No
Brewer	**Yes**	No	No	No	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**	No
Holden	**Yes**	No	No	No	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**	No
Dedham	**Yes**	No	No	No	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**	No
Ellsworth	**Yes**	**Yes**	No	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**	No
Lamoine	**Yes**	**Yes**	No	No	No	No	No	No	No	No	No
Trenton	**Yes**	**Yes**	No	No	**Yes**	No	No	No	No	No	No
Bar Harbor	**Yes**	**Yes**	No	No	**Yes**	No	No	No	No	No	No
Mt Desert	**Yes**	**Yes**	No	No	**Yes**	No	No	No	No	No	No
SW Harbor	**Yes**	**Yes**	No	No	**Yes**	No	No	No	No	No	No
Tremont	**Yes**	**Yes**	No	No	**Yes**	No	No	No	No	No	No

For the trip interchanges where it would be possible to travel by transit, the next step was to determine the percentage of trips that would be made by transit. This was done using a multinomial logit model which splits travel between modes on the basis of differences in in-vehicle travel times, out-of-vehicle travel times, and out-of-pocket costs. The logit model used for these forecasts was in the form of:

$$ms_t = \frac{1}{1 + \left[\frac{I_t}{I_a}\right]^b}$$

where:
ms_t = mode split transit
I_t = the transit impedance
I_a = the auto impedance
b = model coefficient equal to 2.0 for HBW trips, 3.0 for HBO trips, and 2.7 for NHB trips

The impedances used in this formula represent the total time equivalent of using transit or driving, with time values applied to in-vehicle times, out-of-vehicle times, and out-of-pocket costs. To estimate these values, it was necessary to make assumptions regarding the proportion of each town that would be accessible to and from the train, and the proportion of residents and workers that would be able to use Bangor – Trenton corridor transit services. For access to stations, it was assumed that all corridor residents would be able to access service, either by walking, taking a bus, driving, or getting dropped off. This assumption may overstate accessibility as 10% of the households in the corridor do not have vehicles available to them, and not all of these residents may be able to get a ride from others.

For egress from stations, "eyeball" estimates that were developed by examining maps that showed developed areas, available connecting bus services, and the general locations of potential rail or bus stations. These estimates of the proportion of trips to and from each community that would be within areas served by transit were as follows:

- Bangor 75%
- Brewer 75%
- Holden 0% (since beyond walking distance and no local bus service)
- Dedham 0% (since beyond walking distance and no local bus service)
- Ellsworth 50%
- Lamoine 0% (since beyond walking distance and no local bus service)
- Trenton 33%
- Bar Harbor 50%
- Mount Desert 50%
- Southwest Harbor 50%
- Tremont 0% (since beyond walking distance and no local bus service)

In towns where multiple options would be available, general assumptions were made with respect to the proportion of trips that would be made by each mode. For example, residents of Bangor could get to a waterfront station by walking, by driving, or by bus, whereas residents of Holden, most of whom would be beyond walking distance of a station and would not be served by local bus service, would have to drive to Brewer. Similarly, at the destination end, travelers to Bangor could walk or take a bus, but travelers to Ellsworth would have to walk since no local bus service is available. The resulting access and egress mode assumptions were as shown in Table 16.

Table 16
Access and Egress Mode Assumptions

	Access to Stations			Egress from Stations		
	Walk	Drive	Bus	Walk	Drive	Bus
Bangor	5%	75%	20%	67%	0%	33%
Brewer	5%	85%	10%	67%	0%	33%
Holden	0%	100%	0%	0%	0%	0%
Dedham	0%	100%	0%	0%	0%	0%
Ellsworth	10%	90%	0%	100%	0%	0%
Lamoine	0%	100%	0%	0%	0%	0%
Trenton	10%	90%	0%	100%	0%	0%
Bar Harbor	0%	90%	10%	0%	0%	100%
Mount Desert	0%	90%	10%	0%	0%	100%
Southwest Harbor	0%	90%	10%	0%	0%	100%
Tremont	0%	90%	10%	0%	0%	100%

Using these assumed splits of access and egress mode assumptions, weighted average in-vehicle and out-of-vehicle travel times, and travel costs were determined:

In-vehicle Travel Times were calculated as the actual time spent in a vehicle: while driving for automobile trips and while in a transit vehicle for transit trips. In-vehicle travel times for automobile trips for town-to-town trips were developed based on town center to town center driving times calculated using Street Atlas USA. Automobile times for trips within the same town were set at half the travel time to the nearest neighboring town, or at 5 minutes for access trips to train or bus stations.

Transit in-vehicle travel times were based on the Bangor – Trenton times defined in the Operating Plans document for each of the different alternatives:

- Alternative 1: Rail/Bus: Bangor – Brewer bus: 17 minutes; Brewer – Ellsworth rail: 35 minutes
- Alternative 2/Bus: Bangor – Bar Harbor: 80 minutes
- Alternative 3/Busway Bypass: Bangor – Bar Harbor: 65 minutes
- Alternative 4/Light Rail A: Bangor Airport – Trenton: 50 minutes
- Alternative 5/Light Rail B: Bangor Airport – Trenton: 62 minutes

Connecting bus times were set at:

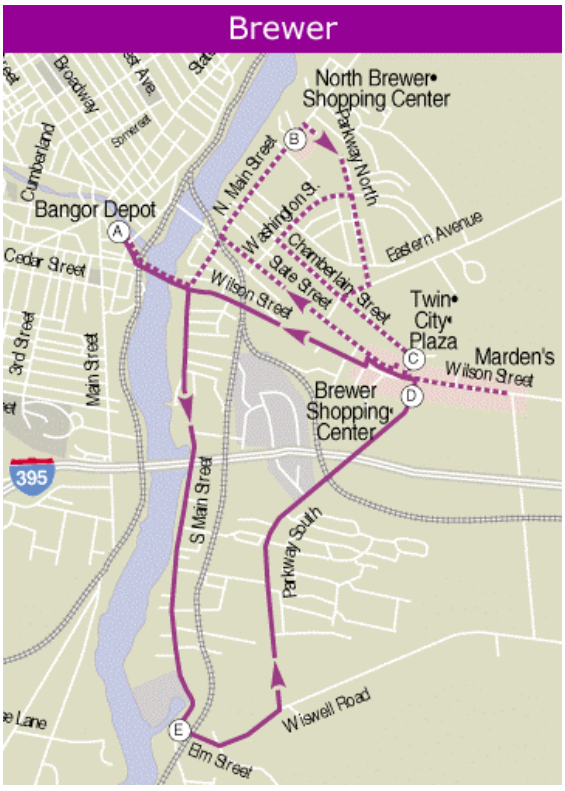
- Trenton to Bar Harbor: 21 minutes with limited intermediate stops
- Trenton to Southwest Harbor: 40 minutes with intermediate stops
- Trenton to Mount Desert: 60 minutes with intermediate stops
- Bar Harbor to Southwest Harbor: 45 minutes with intermediate stops
- Bar Harbor to Mount Desert: 60 minutes with intermediate stops
- Bangor and Brewer local service: 15 minutes based on the average one-way travel time of most existing local routes.

Out-of-Vehicle Travel Time is considered to be more onerous than in-vehicle time, and is calculated as twice the actual amount of time spent outside of a vehicle (walking to or from a car, waiting for a train or a bus, etc.). For all automobile trips, 3 minutes of out-of-vehicle time was included: 1 minute at one end and 2 minutes at the other end.

For transit trips, out-of-vehicle times include a number of components: walk times to bus or rail stations, wait times at bus stops and/or train stations, and walk times to destinations. From some areas, riders would be able to walk, drive, or take a bus to train stations, from some they could walk or drive, and from others they would have to drive. Similarly, at the destination ends of trips, riders to some areas could walk or take a bus; in others where no bus service is available, transit passengers would need to walk. These out-of-vehicle times were set as follows:

- Walk time to train station or bus stop 5 minutes
- Wait time after walking to train station or bus stop: 3 minutes
- Wait time after driving to station or stop: 7.5 minutes
- Bus/rail transfer time 7.5 to 10 minutes

Out-of-Pocket Cost is calculated as the actual out-of-pocket cost associated with a transit trip or an automobile trip. Automobile costs were calculated based on fuel costs using the distance from town center to town center, $1.50 per gallon for gasoline, and 20 mpg. Transit costs were calculated based on a $5.00 Bangor to Trenton fare, and free transfers to buses in Bangor, Brewer, and Trenton. Intermediate rail costs were $1.00 from Bangor to Brewer, $3.00 from Brewer to Ellsworth, and $1.00 from Ellsworth to Trenton. These costs were then translated into time values at 33% of the area's median income, on a per minute basis. This method presumes that residents value their own time at one-third of the rate that they value their work time. In other words, if a worker was paid $15 per hour, he or she would place a value on their own time of $5 per hour. On this basis, and with the 2000 median income for Penobscot and Hancock counties at $41,000, $1 in cost is equivalent to 9 minutes of time.



Using these times and equivalent times, transit impedances were developed for each trip interchange for each alternative and the logit formula applied to predict the total market share that transit would achieve. These shares were then applied to the number of total trips made between all trip interchanges to project total unadjusted corridor transit ridership.

Traffic Assignment

All of the projected corridor transit trips would use Bangor – Trenton corridor services except for trips between Brewer and Bangor, and trips between Bar Harbor and Trenton. Brewer –

Bangor transit trips would be split between the corridor services and The Bus' Brewer route. In July of 2001, The Bus' Brewer route carried approximately 125 riders per day. Based on the projected rates of population and employment growth discussed in previous sections, this level of ridership was assumed to remain relatively stable through 2020. Then, since the Brewer route provides service that is more accessible to most of Brewer and considering the short travel times to Bangor, it is likely that there would be relatively few diversions from local bus to corridor transit services. For the purposes of these projections, it was assumed that only 20% of bus riders would shift to corridor services.

The volume of trips between Bar Harbor and Trenton would be very low, at approximately 20 per alternative. Since this number was so low, no attempt was made to split the trips between corridor Trenton – Bar Harbor services and local Island Explorer Tenton – Bar Harbor service. Instead, it was simply assumed that all corridor riders would use the corridor bus service.

Finally, the unadjusted figures needed to be adjusted to reflect the proposed level of service for Bangor to Trenton services. The logit model method used to produce these forecasts does not explicitly define a level of service. However, many of the inputs do implicitly define a level of service. For example, resident ridership is heavily oriented toward Bangor (approximately 50% of all trips for most alternatives), and the ridership projections presume that riders to and from Bangor will be able to make convenient connections between Bangor – Trenton corridor service and local Bangor services, which generally operate every 30 minutes between approximately 6 am and 6 pm. Similarly, the projections for most alternatives indicate that nearly 50% of all trips would be non-work and non-home-based trips, most of which are made, at least in one direction, outside of normal commuting hours. In other words, the unadjusted projections implicitly presume that all day transit-type would be provided, or a level of service similar to that provided by Bangor's The Bus.

Since the proposed service would operate much less frequently, with three round trips in the morning and three round trips in the afternoon/early evening, the unadjusted ridership projections were factored down to reflect the lower level of service through the use of elasticities. As reported in TCRP's "Traveler Response to Transportation Changes,"[7] for all modes, the average response in terms of frequency changes, including both increases and decreases is approximately +0.5.[8] However, ridership is typically more sensitive when service levels are lower (every 30 minutes or less), and when a transit service serves middle and upper income areas. There is also normally a higher sensitivity to frequency changes on the part of off-peak riders than by peak period riders. Furthermore, while the average of observed elasticities has been +0.5, most observations have been grouped around either +0.3 or +1.0, with those grouped around +1.0 being more suburban systems, and those grouped around +0.3 being central city urban systems. Finally, the few commuter rail observations have ranged between +0.5 and +0.9.

These factors indicate that Bangor – Trenton transit services would exhibit greater sensitivity to frequency differences than most services. Considering this, these forecasts factored down the unadjusted ridership projections to the proposed level of service using an elasticity of +0.75, or the mid-point of the average of +0.5 and the upper bound of +1.0.

[7] Interim Handbook, March 2000.
[8] Meaning that a 1% increase in service will produce a 0.5% increase in ridership.